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RADIO OPERATING SYSTEM AND METHOD FOR OPERATING A RADIO SYSTEM

BACKGROUND

[0001] This~~e invention~~ application relates to a radio operating system, particularly for use with a medical device, and to a method for operating the~~a~~ radio system.

[0002] For operating a device, especially a medical device, such as an X-ray system, an operating ~~element~~ control that is not stationary is often provided. A cable-connected operating ~~element~~ control is known for instance from European Patent Disclosure EP 0 834 891 A2. From it, the possibility is also known of linking an operating ~~element~~ control to a central station in cordless fashion, for instance via an infrared connection. A cordless connection can in principle also be made by means of radio communication. In contrast to an infrared connection, no visual connection would be necessary between the operating ~~element~~ control and the central station, or ~~in other words~~to ~~-~~the device to be triggered. However, that has a disadvantage that a person operating the equipment who, while carrying the operating ~~element~~ control, is moving away from the device to be triggered could change the device settings by unintentionally tripping the operating ~~element~~control. Particularly in the case of medical devices, such an event can be extremely safety- critical. For safety-critical functions of medical devices, radio operations are therefore typically not used.

~~[0003] The invention has the object of expanding the range of use of radio operating systems, particularly for medical devices.~~

BRIEF SUMMARY

~~[0004] This object is attained according to the invention by a radio operating system having the characteristics of claim 1 and by a method for operating a radio system having the characteristics of claim 6. The features and advantages listed below in conjunction with the system apply analogously to the method, and vice versa.~~

[0003] ~~The~~ A radio system ~~that can be operated in accordance with the invention~~ includes ~~what is in general a stationary~~ radio base station unit, which may be stationary and an operating ~~element~~ unit that ~~in general is~~ may not be stationary;~~,~~ ~~and~~ these ~~are also known for short~~may be termed ~~as~~ the ~~parties~~ units ~~to~~ of the radio system. An expansion by an arbitrary number of additional stationary or portable ~~parties~~ units is also possible. Without restricting the general applicability, the ~~assumption~~ discussion herein will refer to ~~below will be~~ a single radio base station unit and a single operating ~~element~~unit, between which radio communication is to be established.

[0004] The radio communication between the ~~parties~~ units of the radio system can be made in various operating modes. ~~To that end,~~ Oone of the ~~parties~~units, which may be ~~preferably~~ the operating unit~~unit~~, has a control ~~unit~~ portion with a first threshold value relating to a reception parameter. The reception parameter, for instance ~~as~~ a reception quality parameter, relates to the reception field intensity, or in the case of digital radio communication, may relate to the bit error rate of the data ~~transmitted~~received. For classifying the reception quality, both the reception field intensity and the bit error rate ~~are preferably~~ may be used. A measurement or estimate of the distance between the ~~parties~~ units of the radio system, which may also be~~made to ascertain~~ used as the reception parameter, ~~is preferably~~may be provided directly by means of a transit time measurement and/or indirectly by the evaluation of the reception quality. For simplicity, the terms "reception parameter" and/or "reception quality parameter" are also used for cases in which the reception properties ~~ascertained~~, in particular the reception quality, are characterized by a plurality of parameters.

[0005] ~~As a function of~~Depending on whether the reception parameter, such as the reception quality parameter, is greater than or less than the threshold value, the reception quality parameter, ~~is exceeded or is undershot by the reception parameter, particularly the reception quality parameter,~~ a standard operating mode or a safety-oriented operating mode of the radio system is activated. Information transmission in the radio system is possible by means of two different command sets: ~~, namely~~ a first, non-safety-critical command set and a second, safety-critical

command set. As long as the operation of the radio system is taking place in the standard operating mode, both command sets are usable without restriction. Conversely, if a switchover is made to the safety-oriented operating mode, for example, when ~~or in other words~~ the reception quality becomes worse, ~~and/~~or the distance between the ~~parties~~ units increases beyond the limit set by the threshold value, then only the first, non-safety-critical command set is usable without restrictions. ~~With regard to the use of the second command set,~~ Rrestrictions are automatically made in the safety-oriented operating mode with respect to use of the second command set.

[0006] In ~~the simplest case~~an aspect, the second command set is blocked entirely in the safety-oriented operating mode. However, the use of the second command set ~~preferably~~ may be ~~remains~~ possible in the safety-oriented operating mode, as long as a confirmation input device, such as a confirmation key, is actuated. In a first alternative, ~~it is provided that~~ the use of the second command set is enabled only during the period of actuation of the confirmation input device. In a second alternative, by the actuation of the confirmation input device in the safety--oriented operating mode, a time slot is ~~opened~~ initiated within which all the command sets, and hence the full functional scope of the standard operating mode, are enabled. In this circumstance~~that case~~, the confirmation input device has the function of a trigger key. ~~Preferably,~~ In another aspect, the time slot that has been ~~opened~~ initiated is ~~retriggered~~ reinitiated after the termination of the operating function tripped by one of the command sets and is thus still open, in a further time interval, for subsequent operation requirements with an arbitrary command set. This ~~version~~ situation is ~~especially~~ advantageous when an operating ~~element~~ unit is embodied as a cordless pedal switch.

[0007] Instead of ~~dividing up~~separating the functions of the operating ~~element~~ unit into two command sets from the standpoint of safety, a more finely graduated classification may be expedient, ~~—~~depending on the type of the device to be triggered. For instance, for functions that for safety reasons should be enabled in every case, especially emergency shutoff functions, ~~it may be provided that~~ to the extent they can be tripped by the operating ~~element~~unit, lower thresholds are set

with regard to the required reception quality thant for other operating functions required for the intended operation of the device ~~to be triggered~~.

[0008] ~~For displaying~~ A visual display of tthe active operating mode status, and ~~especially~~ particularly ~~when~~ the safety-oriented operating mode ~~is activated~~status, ~~an optical display device of a party, in~~ particularly at the operating element, ~~is preferably~~may be provided. By the automatic activation of the ~~optical~~ visual display, for instance in the form of a blinking lighted display, the user is ~~directed~~alerted, upon switchover from the standard operating mode to the safety-oriented operating mode, and ~~to the fact~~ that the reception quality measured as by the ~~party~~ unit at its site is ~~becoming less~~decreasing and/or the distance between the ~~parties~~ units of the radio system are becoming greater. An acoustic warning report ~~is~~ may not be output ~~, in a preferred embodiment,~~ until the user intentionally or unintentionally actuates an input device, especially a key, of the operating ~~element~~unit, ~~with~~ in which a function associated with the second, safety-critical command set, is selected.

[0009] By means of the ~~solely optical~~visual display, but without an ~~not~~ acoustic report in the case of a reception quality below the threshold value, the user carrying the operating element ~~with him~~ is ~~made aware~~alerted, in a way that does not disturb other persons, that he/she is located at ~~the~~an extreme ~~far~~ end of the communications range. This also ~~takes into account~~ accommodates the situations where ~~the fact that~~ the range of the radio communication can be diminished by the ~~most~~ various damping factors, such as many persons present in one room where the ~~parties~~ units of the radio system are also located. In such a case, if the reception parameter drops below the threshold value, then the ~~optical report~~visual display should be understood as an ~~instruction~~ indication to look for a more ~~-~~suitable site for system operation.

[0010] ~~If~~When the transit time of a signal forwarded between the ~~parties~~units, instead of the reception quality at the site of one of the ~~parties~~ units of the radio system, is at least primarily determinative for ~~the definition of~~ the reception parameter, ~~then this makes it especially simple~~it is possible~~, in a locally defined way~~, to limit the region in which radio communication between the ~~parties~~ units is

enabled without restriction. ~~In this way, it is for instance~~ It is thus reliably possible to preclude the tripping of safety-critical functions of the device ~~with~~ in a radio-based operating ~~element~~environment, which is intended for operating a stationary device set up in ~~stationary fashion in~~ one room, ~~from~~ by a unit in a neighboring room.

[0011] In ~~a preferred refinement~~an aspect, a second threshold value ~~pertaining~~ corresponding to a reception parameter ~~is~~ may be provided; if ~~it~~ the reception parameter is less than the second threshold~~is undershot~~, the radio communication between the ~~parties~~ units is ~~shut off~~disabled or terminated. Regardless of whether the termination of the radio communication is ~~done because of undershooting of~~based on the second threshold value or solely based on given physical conditions, especially an excessive distance between the ~~parties~~units, ~~without the fixation of this kind of defined threshold value, it is provided in a preferred embodiment that~~ an acoustic report may be output that informs the user about the ~~establishment~~ termination of the radio communication. The threshold may not be fixed. This makes it ~~easy~~ possible to prevent a user from unintentionally carrying the operating ~~element~~ unit out of reception range, for instance in his/her pocket.

[0012] ~~The advantage of the invention is in particular that because of~~ In a situation where there is ~~the~~ complete or ~~conditional~~ partial blocking of part of the functional scope of a radio-operated device, such as where ~~if~~ the radio reception quality drops below ~~a fixed~~the threshold value ~~and/or over~~or a distance between units is too great, as ascertained by transit time measurement, ~~that is increasing beyond the maximum distance specified by the threshold value, between the device and the device to be triggered,~~ the ~~unrestricted~~ use of the radio operating element remains limited in the desired way to the near vicinity of the device, in particular the medical device, that is to be triggered.

BRIEF DESCRIPTION OF THE DRAWINGS

~~One exemplary embodiment of the invention~~ An example is described in further detail below ~~in terms of~~with reference to the drawings. ~~In the drawing, in each case schematically:~~

[0013] FIG~~ig~~. 1 shows a radio operating system for a medical device; and FIG~~ig~~. 2, in a flow chart, shows various operating states of the radio operating system of FIG~~ig~~. 1.

[0014] FIG~~ig~~. 2, in a flow chart, shows various operating states of the radio operating system of FIG~~ig~~. 1.

[0015] ~~Elements or parameters corresponding to one another are identified by the same reference numerals in both drawings.~~

DETAILED DESCRIPTION OF THE DRAWINGS AND THE PRESENTLY PREFERRED EMBODIMENTS

[0016] Reference will now be made in detail to embodiments, but it will be understood that it is not intended to limit the invention to such embodiments. In the following description, numerous specific details are set forth in order to provide a thorough understanding of the present invention which, however, may be practiced without some or all of these specific details. In other instances, well known process operations have not been described in detail in order not to unnecessarily obscure the description.

[0017] As shown in FIG. 1, ~~A~~a radio operating system 1 includes a stationary radio base station unit 2 and a portable operating ~~element~~ unit 3. A medical device 4 to be triggered, such as an X-ray system or lithotripsy system, is connected to the radio base station unit 2. The functional scope of the device 4 includes safety-relevant functions, such as switching drives or radiation sources, and functions that are not relevant to safety, such as display functions. Both safety-critical and non-safety-critical functions of the device 4 can be controlled by means of the operating ~~element~~ unit 3. Radio communication between the operating ~~element~~ unit 3 and the radio base station unit 2 is established by means of antennas 5, 6~~;~~ ~~and~~ the maximum communications range is approximately 5 to 8 meters. ~~As a~~

~~rule,~~ T~~t~~he user actuating the operating ~~element~~ unit 3 may work~~s~~ under the safety ~~specification~~ rule of maintaining a visual connection with the device 4 to be triggered and thus, in general, also with the radio base station unit 2, which ~~is~~ ~~typically~~may be installed on or in the device 4. ~~For instance~~In an aspect, ~~if~~ should the radio base station 2 ~~is~~ be covered by a cloth hanging down from an examination table, there~~is~~ may be~~is~~ practically no impairment to the radio communication, which is shown in dashed lines and marked FV. ~~To this extent~~In this aspect, the radio communication between the radio base station unit 2 and the operating ~~element~~ unit 3 offers significant advantages, for instance, over an infrared connection. On the other hand, however, the possibility that the user by unintentionally actuating the operating ~~element~~ unit 3 without visual contact with the device 4, for instance in an antechamber to the examination chamber or to the operating room where the device 4 is set up, ~~will~~ and undesirably ~~trip~~ activate functions of the device 4 cannot ~~fundamentally~~ be precluded. This danger is effectively counteracted by operating the operating ~~element~~ unit 3 in operating modes B0, B1, described in further detail below, and also with reference to the flow chart of FIG~~ig~~. 2.

[0018] The operating ~~element~~ unit 3 has a radio module 7, which ~~carries~~ furnishes information about the field intensity, measured by means of the antenna 5, and about the bit error rate of the received data ~~on~~ to a control ~~unit~~ portion ("controller")8~~, hereinafter also called controller for short~~. In addition or as an alternative, the distance between the antennas 5, 6 of the ~~parties~~ units 2, 3 is ascertained by transit-time measurement in the radio operating system 1.

[0019] The controller 8 is also connected to a keypad 9, a keypad controller 10, and a speaker 11 as an acoustic output device. ~~The~~ In an example, keypad 9 ~~, in the exemplary embodiment shown in simplified form,~~ includes four function keys F1, F2, F3, and F4.~~;~~ T~~t~~he designations F1 through F4 represent the functions of the device 4 that can be triggered by the operating ~~element~~ unit 3. In this example, t~~T~~he functions F1, F2 are assigned to a first, non-safety-critical command set BS1, and the functions F3, F4 are assigned to a second, safety-critical command set BS2. As long as the user carrying the operating ~~element~~ unit 3 ~~maintains~~ is ~~a~~

~~slight distance~~within the communications range of the system, ~~intended for regular operation of the device 4,~~ and no significant shields are in the way, all the functions F1 through F4 are enabled without restriction: t~~T~~he operating ~~element~~ unit 3 is in the standard operating mode B1.

[0020] As the distance between the operating element 3 and the radio base station 2 increases, and/or ~~as the parties of the radio operating system 1, increases, and~~/if there are shields between the ~~parties~~ units 2, 3, for instance in the form of a wall in a building, the reception quality of the data stream originating at the radio base station unit 2, which quality is detectable by means of the antenna 5 of the operating ~~element~~ unit 3, becomes worse. The reception quality at the ~~site of the~~ operating ~~element~~ unit 3 is converted, ~~prefer~~by measuring the field intensity and/or ~~and~~ascertaining the bit error rate, into at least one reception quality parameter ("reception parameter" or "reception quality parameter") K~~, or reception parameter or parameter for short,~~ which serves the controller 8 as an input variable. Alternatively, the reception parameter K is a measure ~~for~~ of the distance between the ~~parties~~ units 2, 3 of the radio system, and a decreasing reception parameter K corresponds to an increasing spacing between the ~~parties~~ units 2, 3. The controller 8 compares the parameter K, generated by the radio module 7, with a first threshold value S1.

[0021] The ~~split~~ allocation of functions into the radio module 7 on the one hand and the controller 8 on the other should be understood as merely symbolic. ~~In fact,~~ A~~a~~ plurality or all of the components, that is, the radio module 7, controller 8 and keypad controller 10, ~~are for instance~~ may be realized ~~embodied~~ as one integral component, and both open- and closed-loop control functions can also be attained by software. It is equally possible as an alternative, for functions shown symbolically inside the operating ~~element~~ unit 3 also to be integrated with the radio base station unit 2 and/or the device 4.

[0022] If the reception parameter K is less than the first threshold value S1 ~~is undershot by the reception parameter K, or in other words particularly if the reception quality is becoming less~~, a further, safety-oriented operating mode B0 is activated. The functions F1, F2 associated with the first, non-safety-critical

command set BS1 are enabled without change. ~~Conversely~~However, the functions F3, F4 associated with the second, safety-critical command set BS2 are not usable merely by actuating the corresponding keys of the operating ~~element~~ unit 3. Instead, to enable the safety–critical functions F3, F4, the actuation of an enabled key 12, as a confirmation input device, is required.

[0023] In a first alternative, the use of the functions F3, F4 of the safety-critical command set BS2 is enabled only ~~as~~ so long as the enable key 12 continues to be depressed. In a second alternative, the full functional scope of the standard operating mode B1 that includes both command sets BS1, BS2 is enabled, for instance for a period of 10 seconds, by a brief actuation of the enable key 12. The user is informed of the necessity of actuating the enable key 12 by an acoustic warning signal output by the speaker 11, as soon as ~~he~~ the user selects one of the functions F3, F4 in the safety-oriented operating mode B0 without having first enabled~~ing them~~the functions. In this way, ~~it is reliably precluded that~~ the user is precluded ~~will~~ from unintentionally tripping a safety-critical function of the device 4. The restricted use of functions, ~~possible in this exemplary embodiment~~ only after actuation of the enable key 12~~, of~~ for the safety-critical command set BS2 in the safety-oriented operating mode B0, is symbolized in FIG~~ig~~. 2 by the term BS2 ~~enclosed in parentheses~~.

[0024] ~~If the~~When the user, carrying the operating ~~element~~ unit 3, moves out of the near vicinity of the radio base station 2 within which the standard operating mode B0 is possible, an acoustic warning is not automatically given. The safety-oriented operating mode B0 activated ~~in that case, however,~~and the activation of the safety-oriented operating mode B0 is displayed by ~~means of~~ a light-emitting diode 13 as a visual display device in an undisturbing way. If only the functions F1, F2 associated with the non-safety-critical command set BS1 are selected, no acoustic ~~report~~ warning is made. ~~At the same time~~But, the user is informed of the fact that he/she is located in a region of reduced reception field intensity and/or an increased bit error rate by the visual display. In this way, great user friendliness of the radio operating system 1 is provided ~~for~~.

[0025] If the operating ~~element~~ unit 3 is moved farther from the radio base station unit 2, or the reception quality of the location of the antenna 5 is further reduced in some other way, then the parameter K drops below a threshold value S2 specified in the controller 8. In that case, all the functions F1 through F4 are blocked. Information to the user is accordingly provided by an acoustic ~~report~~warning, output via the speaker 11~~,~~. The acoustic signal may be, for ~~as~~ a defined sequence of tones, or ~~as~~ speech output. If the operating ~~element~~ unit 3, in addition to the keypad 9~~,~~ or combined with ~~it~~the operating unit 3, may also ha~~s~~ves an optical output device, for instance in the form of a touch sensitive display screen, then the output of an ~~o~~visual~~ptical~~ report, for instance in the form of a clear text display, ~~is preferably~~ may be provided in addition or alternatively to the acoustic warning.

[0026] Although the present invention has been explained by way of the examples described above, it should be understood to the ordinary skilled person in the art that the invention is not limited to the examples, but rather that various changes or modifications thereof are possible without departing from the spirit of the invention. Accordingly, the scope of the invention shall be determined only by the appended claims and their equivalents.